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KALAMAZOO RIVER  
SUMMARY OF RECENT WATER QUALITY STUDIES

PREPARED BY:  
COUNTY OF ALLEGAN  
AND  
STS CONSULTANTS, LTD.

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## 1. INTRODUCTION

Due to dam safety considerations and interest shown by the County of Allegan in restoring hydroelectric production, the Michigan Department of Natural Resources (MDNR) is confronted with management decisions regarding the Trowbridge, Otsego and Plainwell Dams on the Kalamazoo River. In the past two years, over twelve studies have been conducted examining the Kalamazoo River between the Cities of Kalamazoo and Allegan. These studies address a variety of water quality considerations including dissolved oxygen and PCB contamination. These studies are listed in the reference section of this report. To assist the MDNR in the evaluation of the various management options concerning the dams, this report summarizes the results and findings of the referenced reports. New information is also presented concerning the reservoir hydraulics. The report is broken down into various sections which deal separately with historical background, hydraulic information, PCB contamination, dissolved oxygen concentrations and dam safety issues.

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## 2. HISTORICAL BACKGROUND

December 1965	Hydropower operations ceased at Plainwell, Otsego and Trowbridge Dams.
July 26, 1966	Memorandum to Director Ralph A. McMullen from MDNR Lands Division, Water Resource Commission, and Fish Division stating need to maintain reservoirs to protect downstream waters from extension of oxygen demand problems and prevent erosion of sediments downstream.
1967	Plainwell, Otsego and Trowbridge Dams sold to MDNR.
April 1970	The gates are raised and permanently opened at some of the dams. It was concluded that this was the time the impoundments were lowered.
March 1974	Memorandum to Assistant State Attorney General from W. E. Waycack, Regional Manager, requesting a letter releasing the United States Marine Corps demolition group from liability while doing the work to demolish dam powerhouses. Bureau of Resource Management reiterates water resources staff's concern that the dams be retained to serve as settling basins for waste being carried by the river, and removal would further degradate the quality of downstream waters.

November 1979	National Dam Safety Program Inspection Report for Plainwell Dam. Otsego and Trowbridge Dams not inspected.
June 1981	Memorandum from Assistant State Attorney General stating the Department of Natural Resources Commission may exchange land for acquisition by developers of the Kalamazoo River Dams.
June 1981	Environmental Enforcement Division anticipates no water quality problems if the three dams were sold. However, there is concern for resuspension and downstream transport of sediment contaminants if the dams were removed.
August 1981	Wetland Protection Unit of Land Resources Programs Division noted a significant amount of wetlands that could be provided by reimpounding the dams.
September 1981	Memorandum from Director Howard Tanner directing the department to retain the property involved and pursue feasibility of removing the dams.
December 1981	DNR estimates show removal cost of dams at \$3.6 million. Estimated cost to remove accumulated sediments would be \$32.2 million.

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May 1982	Preliminary permit issued on Otsego Dam by FERC.
February 1983	Meeting between MDNR and Allegan County discussing restoration of Kalamazoo River Dams.
September 9, 1983	Study proposal presented to MDNR by Allegan County outlining necessary studies required for the transfer of ownership of the Kalamazoo River Dams.
December 1983	Preliminary permit issued on Trowbridge Dam by FERC.
February 17, 1984	Additional studies completed by Allegan County. Meeting with MDNR to finalize technical discussions.

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### 3. HYDRAULIC STUDIES OF THE TROWBRIDGE RESERVOIR

The Trowbridge Dam has the largest reservoir of the three dams owned by the MDNR. A detailed topographic map with 1 foot contours was obtained by STS from aerial photography taken in October 1983. This topographic map provided the necessary information to conduct a detailed analysis of the reservoir sediments and reservoir flooding conditions. Although a detailed topographic map was obtained only for the Trowbridge Dam, the following results can be considered to apply to the Otsego and Plainwell Dams due to their similar spillway design.

Figures 1 through 3 show the historic accumulation of sediments behind the Trowbridge Dam. Figure 1 shows the original river bottom and water depths behind the Trowbridge Dam at the time of construction around 1900. When the hydroelectric plant was retired in 1965, a large amount of sediment had accumulated to the sill elevation of the dam as shown in Figure 2. In 1970, the MDNR "locked open" the dam flood gates allowing the reservoir to drain resulting in the present profile is shown in Figure 3.

As shown in Figure 3, the Kalamazoo River has not returned to its original state. When the dam gates were opened, the river canal scoured through the sediments to the sill elevation of the dam, which is approximately 15 feet above the original river bottom at the dam.

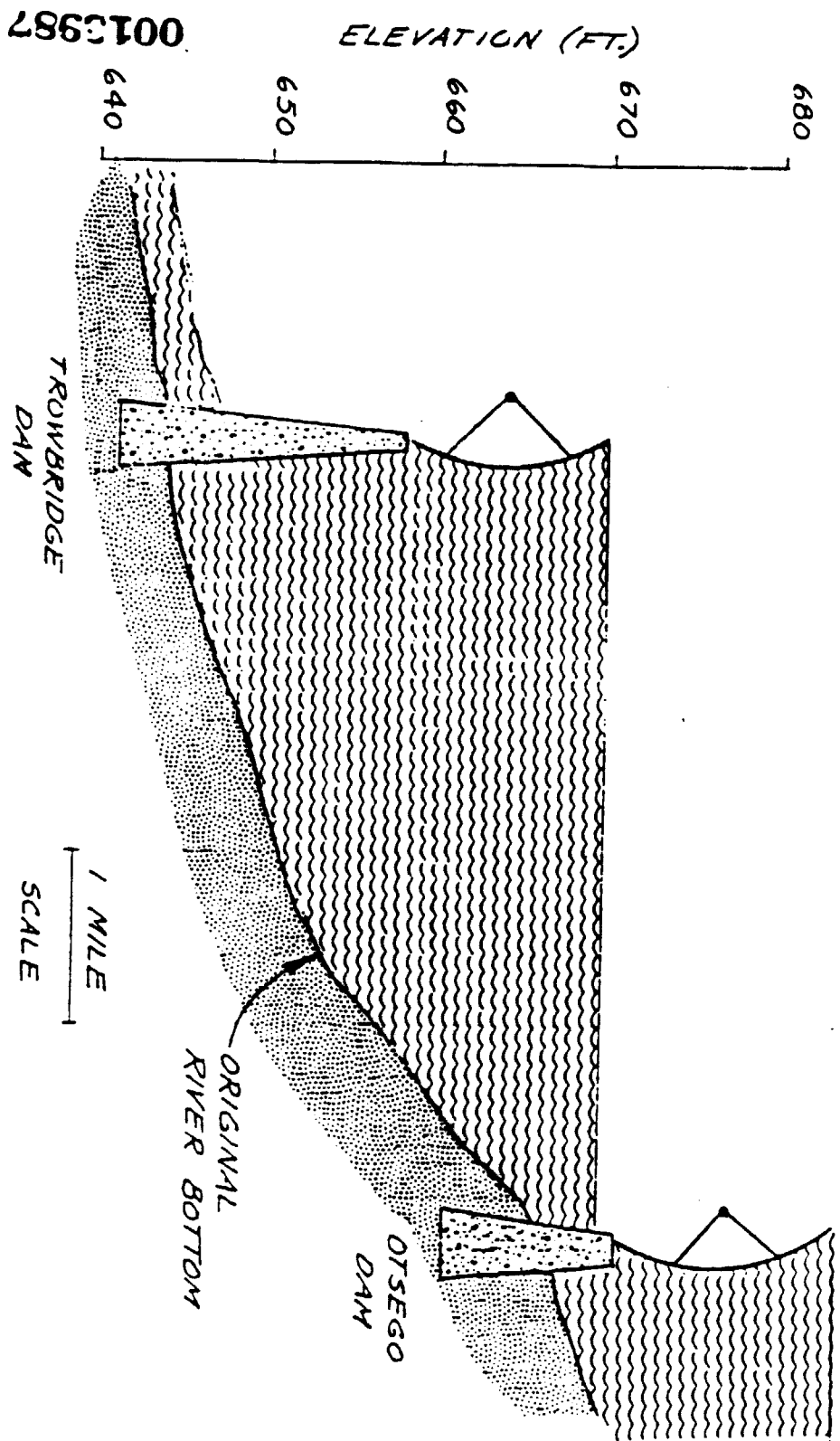
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The water surface elevation behind the Trowbridge Dam is controlled by the discharge characteristics of the Trowbridge Dam spillway. The Trowbridge Dam spillway capacity curve is shown in Figure 4. As the spillway acts as a restriction to the river, the water level in the Trowbridge reservoir fluctuates dependent on the river flow rate. Figures 5 and 6 shows the water surface area behind the Trowbridge Dam for the normal annual low and high flow periods, respectively. This information is based on the average annual minimum and maximum flows since 1970 (when the gates were opened) of 523 cfs and 4,693 cfs, based on the USGS Fennville Gage (corrected for drainage area). Based on the spillway capacity, this translates to an average annual water surface elevation variation behind the Trowbridge Dam of 659.2 feet to 665.6 feet U.S.G.S. with the impounded areas varying between 157 acres and 432 acres, respectively. The former reservoir water surface elevation was 669.4 feet U.S.G.S. with an area of 558 acres. As such, the annual variation of water surface inundates between 28 to 77% of the former reservoir area under current conditions. Figure 7 shows the water surface elevation behind the Trowbridge Dam for water year 1978. The water surface variation for this year was approximately 10 feet and on July 1, 1978, the water surface was at elevation 669.2 which essentially filled the reservoir to the former water surface elevation. This water surface fluctuation is undoubtedly resulting in sediment erosion and downstream transport.

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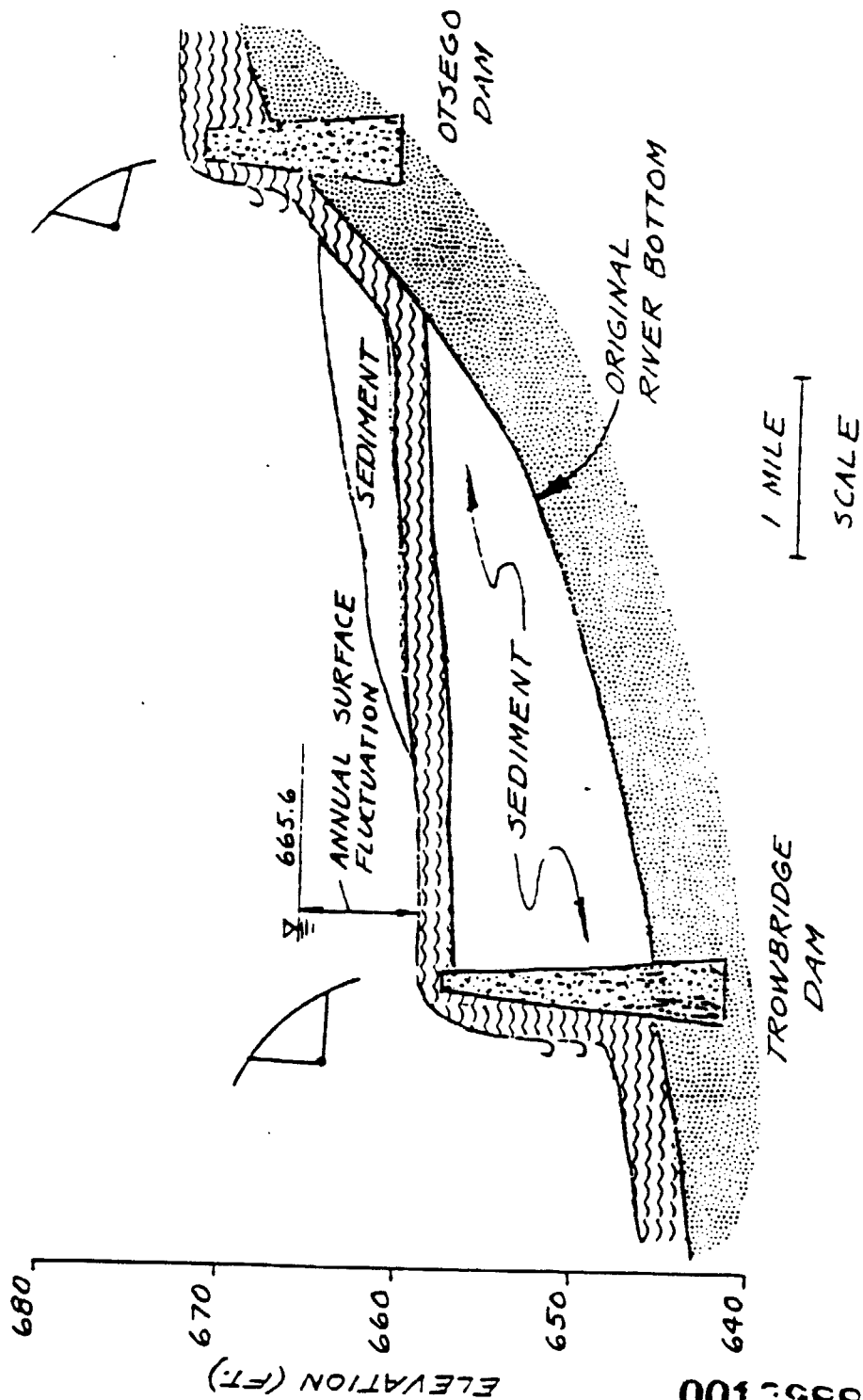
**FIGURE 1**  
**TROWBRIDGE RESERVOIR**  
**WHEN ORIGINALLY CONSTRUCTED**



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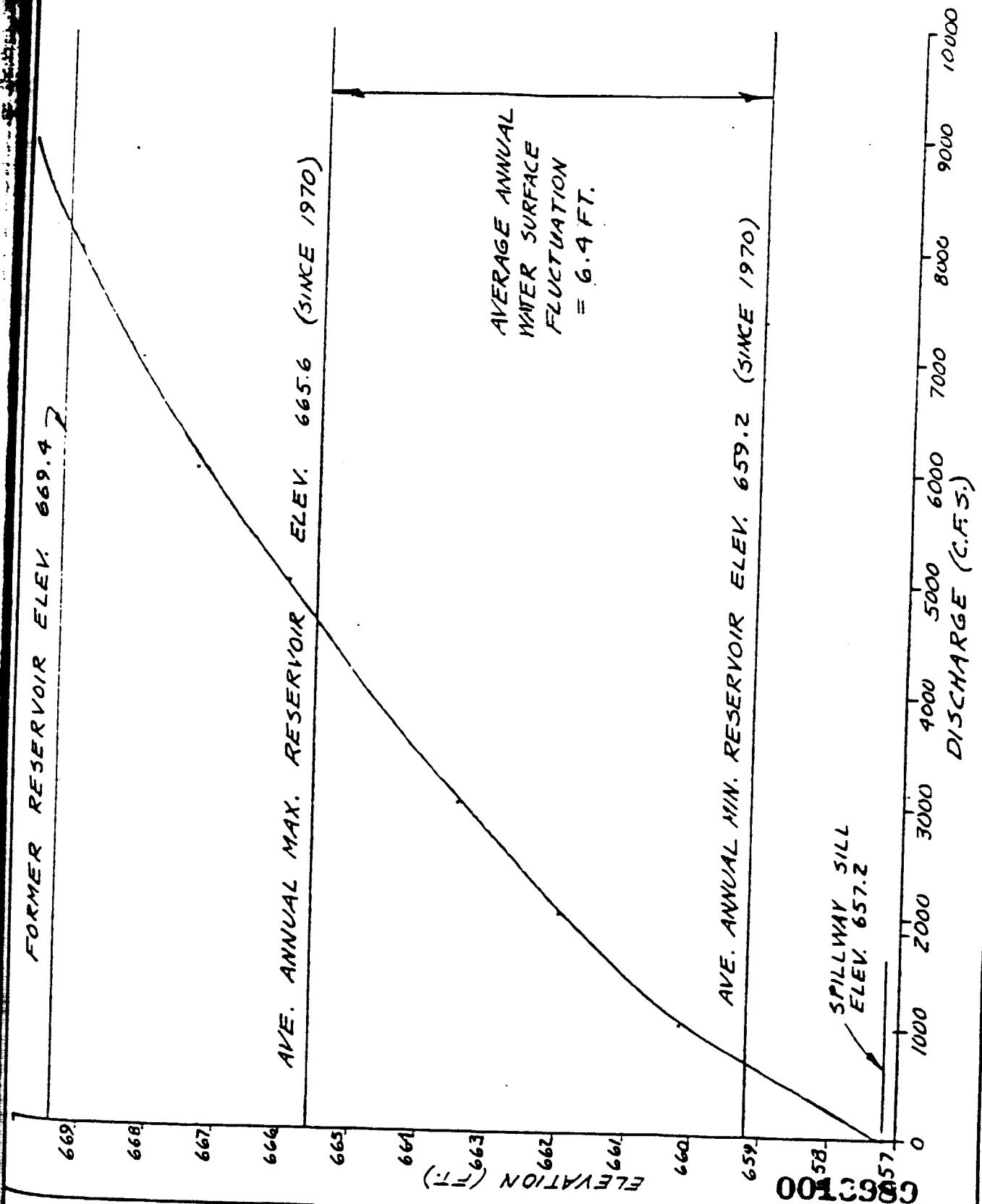
# FIGURE 3

EXISTING TROWBRIDGE RESERVOIR



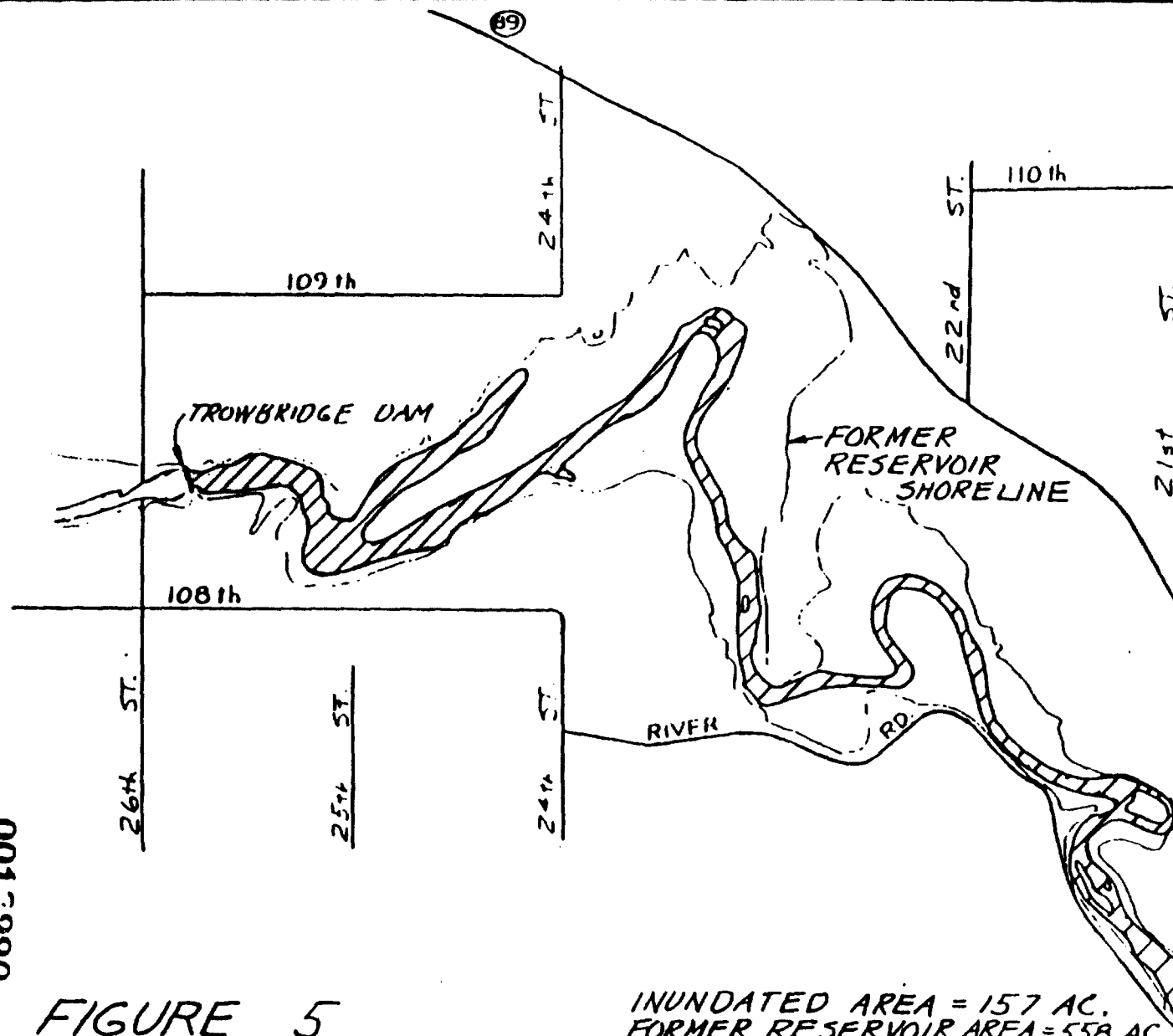
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**FIGURE 4**  
**TROWBRIDGE DAM**  
**SPILLWAY CAPACITY CURVE**

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**FIGURE 5**  
 EXISTING TROWBRIDGE DAM  
 RESERVOIR WATER SURFACE  
 AREA DURING AVERAGE ANNUAL  
 LOW FLOW CONDITIONS

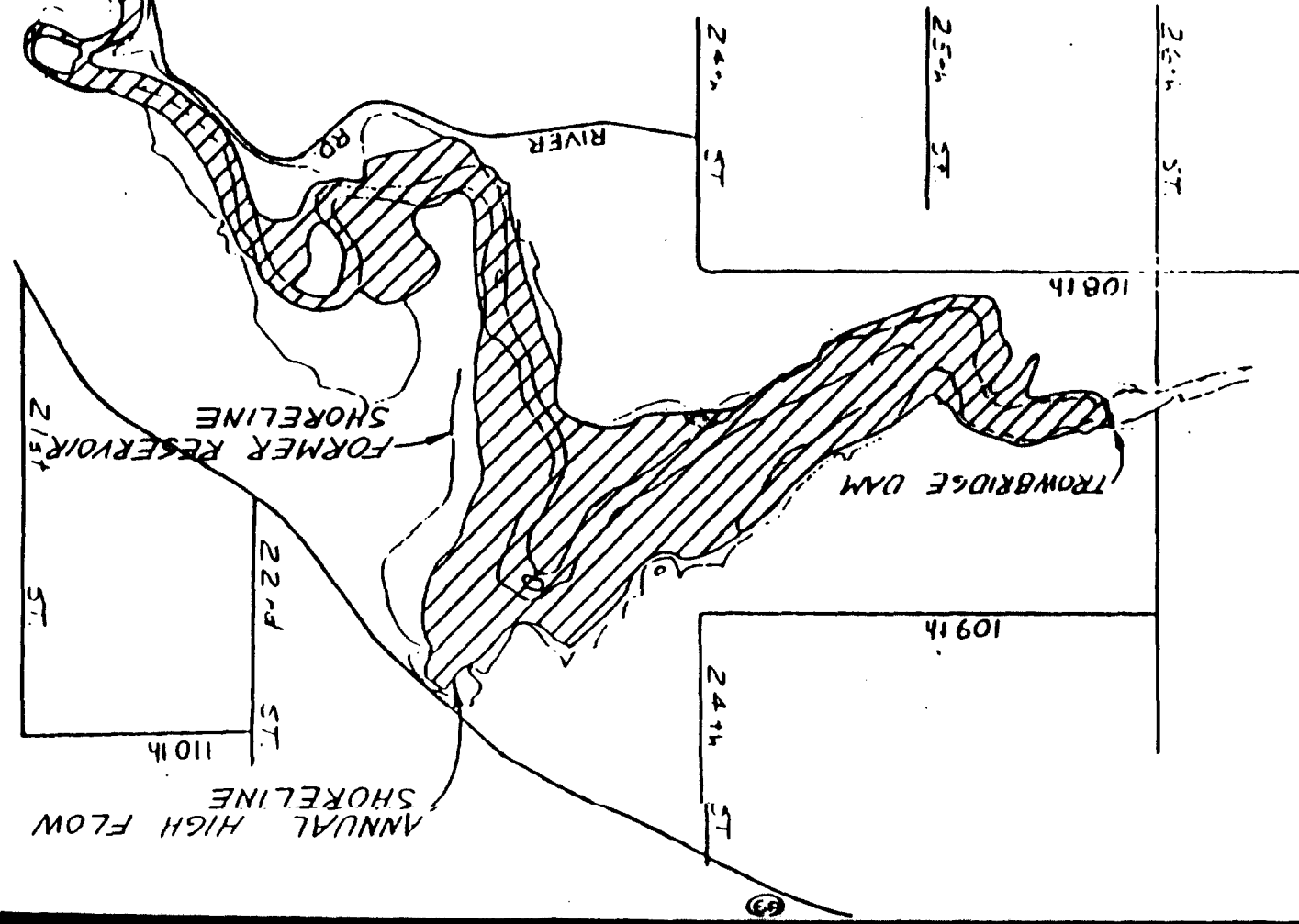
INUNDATED AREA = 157 AC.  
 FORMER RESERVOIR AREA = 558 AC.  
 28% OF FORMER RESERVOIR IS INUNDATED  
 AVERAGE ANNUAL MIN. FLOW = 523 C.F.S. (SINCE 1970)

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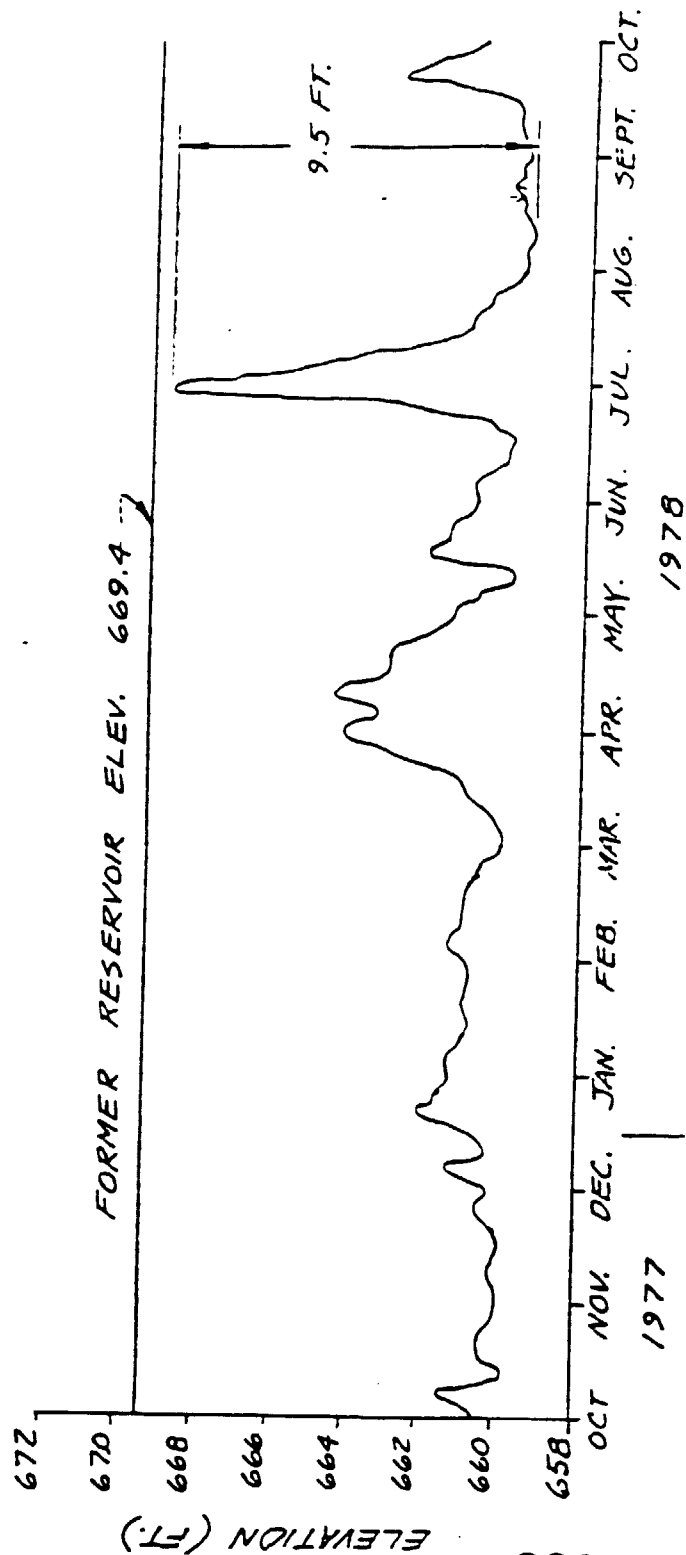
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**FIGURE 6**  
**EXISTING TROWBRIDGE RESERVOIR**  
**WATER SURFACE AREA DURING**  
**AVERAGE ANNUAL HIGH FLOW**  
**CONDITIONS**



INUNDATED AREA = 432 AC.  
 FORMER RESERVOIR AREA = 558 AC.  
 77% OF FORMER RESERVOIR IS INUNDATED  
 AVERAGE ANNUAL MAX. FLOW = 4693 CFS. (SINCE 1970)  
 RESERVOIR WATER SURFACE ELEV. = 665.6 (USGS.)

**FIGURE 7**  
**TROIWBRIDGE RESERVOIR**  
**WATER SURFACE ELEVATIONS**  
**WATER YEAR 1978**



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#### 4. PCB CONTAMINATION IN SEDIMENTS

Numerous sediment sampling programs and studies have been conducted for PCB contamination determination (References 3, 5, 6, 7, 9 and 12). PCB's are present in the sediments throughout the Kalamazoo River between Kalamazoo and Lake Allegan as shown on Figure 8. High PCB concentrations have been found in Portage Creek, a tributary of the Kalamazoo River, with a maximum concentration of 582 ppm. The highest PCB concentrations in the Kalamazoo River have been found near the confluence of Portage Creek and the Kalamazoo River with concentrations as high as 85 ppm. Concentrations in the sediments downstream of Kalamazoo are in the order of 10 to 20 ppm.

Sampling locations and concentrations in the reservoirs of the Trowbridge, Otsego and Plainwell Dams are shown in Figures 9 through 11. The average PCB concentrations in the Trowbridge, Otsego and Plainwell reservoirs were found to be <sup>11-20 10</sup>15, 5 and <sup>20-30 10</sup>14 ppm, respectively. Core samples showed higher concentrations in the deeper sediments. The sampling program did not detect any "hot spots" of PCB's in the reservoirs. However, in the Trowbridge Dam reservoir, higher concentrations were found in the river bottom and immediate shoreline compared to the exposed sediments in higher elevations. This is probably the result of the scouring of the river into the lower more highly contaminated sediments upon the opening of the flood gates in 1970.

Core 11-20 10 20-30 10  
0.6 - 56 3.8 - 73 11-42 17/4

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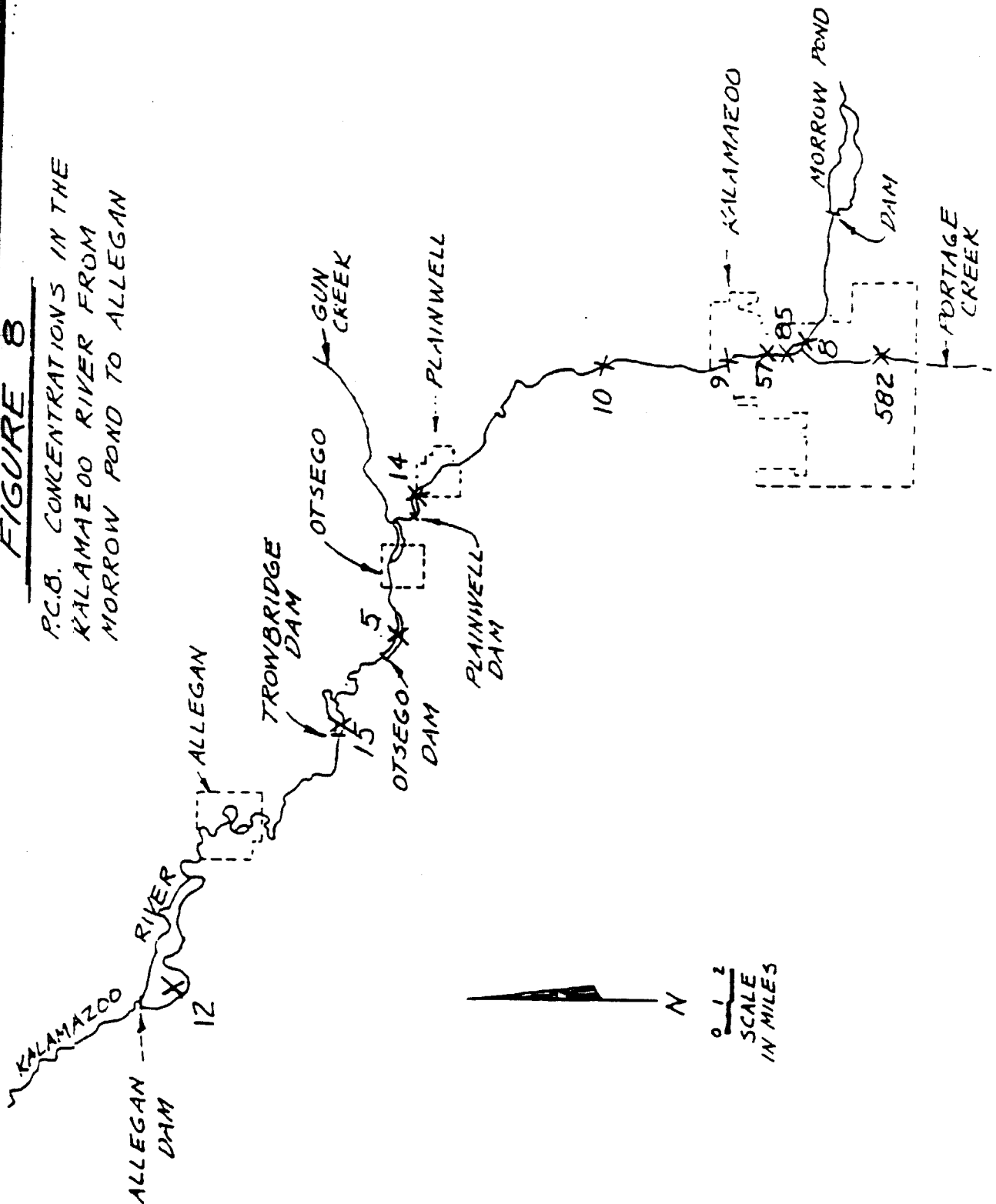


Fish sampling to determine PCB concentrations has also been conducted (Reference 2, 4). Shown in Figure 12 is the results of the fish sampling taken in 1976 and 1981 near Plainwell and in Lake Allegan. Significant reductions in the PCB level in the fish has been measured. A reduction of 9 ppm to 1 ppm was observed in fish near Plainwell and from 20 ppm to 6 ppm in Lake Allegan. An additional fish sampling study was conducted in the summer of 1983. The results of this study should be available in spring 1984.

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# FIGURE 8

PC.B. CONCENTRATIONS IN THE  
KALAMAZOO RIVER FROM  
MORROW POND TO ALLEGAN



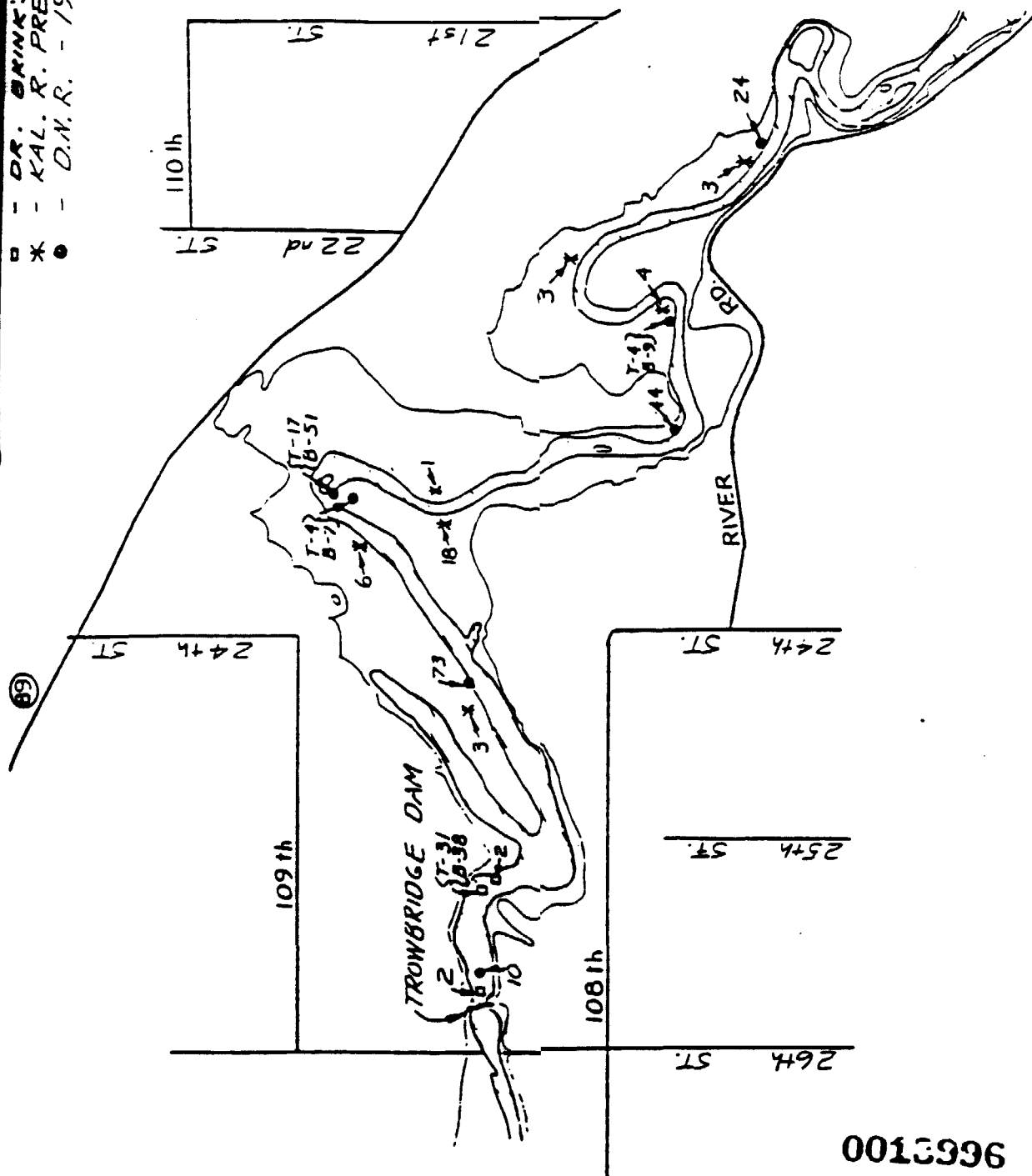
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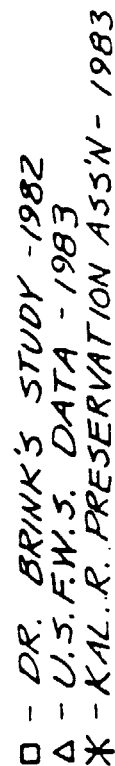
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FIGURE 9  
P.C.B. CONCENTRATIONS IN THE  
TROWBRIDGE DAM RESERVOIR

AVERAGE OF ALL SAMPLES = 15 p.p.m.

**FIGURE 10**



AVERAGE OF ALL SAMPLES = 5 ppm.

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